The impact of marriage and parenthood on male body mass index: static and dynamic effects

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Abstract

Rationale Numerous cross-sectional studies investigated the link between marital status and BMI in the context of competing social science theories (marriage market, marriage selection, marriage protection and social obligation), frequently offering conflicting theoretical predictions and conflicting empirical findings.
Objective This study aims to analyse the effects of marriage, divorce, pregnancy and parenthood on male BMI in a longitudinal setting, therefore avoiding the estimation bias of cross-sectional studies and allowing for an analysis of BMI fluctuation over time and the dynamic effects of these events.
Method Using the Panel Study of Income Dynamics 1999-2013 dataset ($N = 8,729$), this study is the first to employ a dynamic panel-data estimation to examine the static and dynamic effects of marriage, divorce, and fatherhood on male BMI.
Results This study finds that married men have higher BMI, however this static effect is largely driven by marital status changes, namely an increase in BMI in the period following marriage, and a decrease in BMI preceding and following divorce. This is consistent with the marriage market and social obligation theories and rejects the marriage protection theory. Moreover, this research finds no evidence of marriage selection theory. These two theories are extended to parenthood. No significant BMI effects are identified during wife's pregnancy, instead men tend to have higher BMI in the periods following childbirth. Finally, this analysis finds a considerable contemporaneous correlation between husband's and wife's BMI over the course of marriage.

Keywords: USA, male BMI; marriage; divorce; parenthood; childbirth; dynamic panel-data estimation

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1 Motivation

Excess weight is a risk factor for many chronic diseases, including cardiovascular diseases, diabetes and certain cancers (Field et al., 2001; Mokdad et al., 2003; Visscher and Seidell, 2001). Consequently, obesity imposes a cost to the health care system (Thorpe et al., 2004; Withrow and Alter, 2011), negatively impacts individual productivity and coincides with lower reported wellbeing (Jia and Lubetkin, 2005; Katsaiti, 2012). Given major public health concerns about obesity and individual interest in diet and fitness, it is key to better understand what social science factors can cause weight fluctuations.

There are several theories that link Body Mass Index (BMI), and marital status and parenthood. This study examines the static and dynamic of these life course events in the context of *marriage market, marriage selection, marriage protection and social obligation theories.* Moreover, the empirical findings on parenthood and male BMI link to the emerging adaptive perspectives on the biology of fatherhood.

As this study examines the relationship between male BMI, and marital status and parenthood, in the following two subsections these themes are analysed separately. The first subsection introduces the theoretical and empirical links between marriage, divorce and BMI, and the second one between pregnancy, early parenthood and BMI. While the static effects have been informed by the literature and are based on previous empirical research, there is much less to none prior empirical research on the dynamic effects measuring the change in male BMI due to changes in marital status, pregnancy and in the following periods. Though the study of the latter is largely exploratory, all examined relationships have been formulated as hypotheses for reader's convenience, and due to equivalence to closed questions and the quantitative nature of this study. All effects are analysed in the context of the aforementioned theories.

1.1 Male BMI and changes in marital status

1.1.1 Theoretical predictions and empirical findings

Marriage protection theory states that married adults will have better physical health as a result of the increased social support and reduced incidence of risky behaviour among married individuals. *Social obligation theory* states that those in relationships may eat more regular meals and/or richer and denser foods due to social obligations which may arise because of marriage. *Marriage market theory* implies that individuals who are on the matching market have higher incentives and exert more effort to stay fit, than individuals who are already or still married (Averett et al., 2008a; Lundborg et al., 2007), resulting in higher BMI among married than non-married individuals. *Marriage selection theory* states that individuals with lower BMI are more likely to be selected as a spouse (Mukhopadhyay, 2008). Under this theory marriage has no impact on individual BMI but rather people with lower BMI are more likely to become married.

These theories make conflicting predictions whether married individuals have higher or lower BMI than non-married individuals. However, when examining the link between marriage and BMI over time, three of these approaches are not mutually exclusive. Specifically, under the *marriage selection theory* partners are expected to have lower BMI before and upon becoming married, and afterwards, in line with *social obligation* and marriage market theories, due to a change in lifestyle and without the matching market incentives, gain weight. Examining BMI fluctuation in the context of timing of marriage and divorce can shed light on the coexistence of these theories.

Investigating BMI time path may also help explain mixed finding with regards to BMI and marital status in cross-sectional studies. For instance, Noppa and Bengtsson (1980) and Sund et al. (2010) find that married individuals have lower BMI, Kittel et al. (1978) and Umberson et al. (2009) find no differences in BMI between married and non-married individuals, and then a large number of studies found higher BMI among married individuals (Ball et al., 2002; Hahn, 1993; Heineck, 2006; Klein, 2011;

Sobal and Rauschenbach, 2003; Wilson, 2012; Sanz-de Galdeano, 2005). One of the possible reasons for contradicting results is not considering in a longitudinal setting individual effects and dynamic effects of marital status changes by measuring the BMI impact of periods preceding and following marriage and divorce.

Mata et al. (2015) based on nine representative studies across Europe find that controlling for age and socioeconomic status never married respondents had a lower BMI than married respondent. The authors point out that the limitation of their work lies in the fact that the data used is cross-sectional and therefore causal inference cannot be drawn and changes over time could not be tested. There have been significantly fewer longitudinal studies and among these Meltzer et al. (2013); Averett et al. (2013) find that either both partners, or women in particular, gain weight across the marital transition. Dinour et al. (2012) in their literature review of association between marital transitions and changes in BMI find that transitions into marriage were associated with weight gain, whereas transitions out of marriage were associated with weight loss.

1.1.2 Research hypotheses

In the context of marital status, this study will test five hypotheses. Hypothesis one has been supported by numerous empirical research and hypotheses 2-4 are on the dynamic effects of BMI change due to changes in marital status that can likely account for much of the static effect of higher BMI among married men found in the literature.

Hypothesis 1 (static effect) *Married males have higher BMI than not married men.*

This hypothesis is consistent with 2 out of 4 discussed theories, namely *marriage market* and *social obligation theory.*

Hypothesis 2 (dynamic effect) *Men's BMI is lower in the period preceding marriage.*

This hypothesis is consistent with the *marriage selection theory* as fitter men are more likely to marry.

Hypothesis 3 (dynamic effect) *Men's BMI increases in the period following* *marriage.*

Marriage market theory implies high incentives to be fit when in the marriage market and decrease in these incentives resulting in higher BMI after becoming married. *Social obligation theory* explains increase in BMI following marriage as a lifestyle change. This hypothesis is not consistent with *marriage protection theory*, as this theory predicts that married adults will have better physical health and lower BMI.

Hypothesis 4 (dynamic effect) *Men's BMI decreases in the time period preceding and following divorce.*

A decrease in BMI in both of those periods supports *marriage market theory* as in anticipation of re-entering the marriage market incentive to be fit increase. *Social obligations* may also change in the period preceding dissolution of marriage leading to a lower BMI. This hypothesis is not linked to *marriage selection theory*, as the latter does not capture intentional behaviour in response to changing incentives. Finally, it is not consistent with *marriage protection theory.*

Hypothesis 5 (continuous effect) *Men's BMI increases when wife's BMI increase and vice versa.*

This hypothesis has no identification power and it is consistent with all presented theories, as plausibly the same behavioral incentives and motivations apply to wives as husbands. Still, if true this is an important empirical pattern and a relevant control variable in estimating dynamic effects proposed in this article.

1.2 Male BMI and transition to parenthood

1.2.1 Theory and empirical findings

Almost all reviewed articles either excluded pregnant females, or did not report how pregnant females were treated in the data. In a longitudinal study Meltzer et al. (2013) controlled for pregnancy when investigating the impact of marital satisfaction on BMI of 169 females and found that spouses in satisfying relationship relax their effort to maintain weight, a finding in line with the *marriage market theory.* Umberson et al.

(2011) using growth curve analysis show that parenthood is associated with trajectories of long term weight gain. Based on 4 survey waves every 3-7 years they also examine the impact of transitions into and out of marriage and find no effect of the former and a negative effect on BMI of the latter.

Clearly pregnancy naturally increases female BMI but there has been very little research has been done on the impact of pregnancy, childbirth and following periods of childcare on male BMI. Indeed, Gray and Anderson (2010) emphasize that studies addressing difference in men's weight associated with marital status are more available than studies on weight and fatherhood. One of the first and few studies on the topic by Clinton (1987) found based on self-reported information that expectant fathers experienced more unanticipated weight gain during partner's third trimester compared with non-father controls. An important study by Gettler et al. finds that partnered men residing with children have elevated adiposity, measured also using BMI, compared to never married men not residing with children. They also have lower testosterone, which accounts for the groups' adiposity differences, suggesting this might be the pathway between life history status and weight gain.

There is a large body of *adaptive theory* research examining fathers' testosterone decline following childbirth pointing to its evolutionary benefits. Longitudinal study by Gettler et al. (2011) demonstrates that men who became partnered fathers experienced large declines in testosterone. In a study by Edelstein et al. (2017) expectant fathers showed prenatal declines in testosterone and estradiol, and larger declines in these hormones were associated with greater contributions to household and infant care tasks. This is an alternative explanation of the link between pregnancy and childbirth and male BMI increases, as reduced testosterone has been shown to contribute to increases in adiposity in men in industrialized countries (Mauras et al., 1998).

Regarding the empirical link between parenthood, and healthy diet and exercise, most studies find it to be negative. Bellows-Riecken and Rhodes (2008) in their review of existing literature found a negative relationship between parenthood and physical activity involvement. According to Berge et al. (2011), both mothers and fathers have lower amounts of physical activity compared with non-parents. Mothers had higher mean BMIs than women without children. No difference was observed in BMIs between fathers and men without children. Nomaguchi and Bianchi (2004) found that married people and parents spend less time exercising and having a young child in the household was significantly related to a decreased physical activity time. Garfield et al. (2016) demonstrate that entrance into fatherhood is associated with an increase in BMI trajectory for both nonresident and resident fathers.

Otherwise, most insights on the impact of pregnancy and childbirth on fathers' weight are based on ad hoc surveys. For instance, according to the 2009 Onepoll study, an average expectant father gains a 6.35 kg during his partner's pregnancy. The listed reasons included larger meals, more snacks around the house, eating more to make their partner feel better and going more frequently to pubs and restaurants before the baby comes. These are consistent with *social obligation theory*.

Regarding fatherhood itself *social obligation theory* does not deliver a clear prediction. Father's behaviour depends on a variety of factors. For instance whether men who become fathers increase their work hours or to the contrary, spend less time in paid work, and more time with their children depends, among other determinants, on age, education, race, class and gender ideology (Glauber and Gozjolko (2011), Bulanda (2004), Kaufman and Uhlenberg (2000)). Although this study controls for a number of these factors, given several other unobserved determinants, this section has an exploratory character.

Regarding the impact of pregnancy on male BMI *marriage market theory* makes similar predictions to *social obligation theory* and *adaptive theory*. Having children solidifies a marriage as it increases the utility from staying married and decreases the value of an outside option of divorce (remarrying or being single). Hence the incentives to stay fit due to either the risk of re-entering the matching market, or the need to remain attractive for one's partner, decrease.

As for the periods following childbirth, (*adaptive* and *marriage market theory* point to similar BMI dynamics. Specifically, weight gain is expected to be more significant in early fatherhood as then *marriage market* incentives and *adaptive* benefits are particularly high. As emphasized above, *social obligation theory* offers no clear prediction.

1.2.2 Research hypotheses

This largely exploratory section examines associations between fatherhood and BMI. Following the structure used in the previous subsection, first hypothesis is on the static effect of fatherhood and the following two hypotheses focus on the timing, i.e. on BMI changes during pregnancy and in the periods following childbirth.

Hypothesis 6 (static effect) *Fathers of children under the age of 19 have higher BMI than childless men and fathers of grown children.*

Hypothesis 7 (dynamic effect) *Men's BMI increases during wife's pregnancy.*

Hypothesis 8 (dynamic effect) *Men's BMI increases in the periods following childbirth.*

Moreover, as married individuals are more likely to have children than non-married ones, examining the effects of pregnancy and fatherhood is key to understanding what is driving higher BMI among married individuals that most studies find.

2 Methods

2.1 Data

This article uses US data from the Panel Study of Income Dynamics (PSID). This is a longitudinal household survey collecting biennially a wide range of individual and household demographic, income, and labor market variables. In addition, in all of the most recent waves (1999-2013) PSID provides self-reported weight (in pounds) and height (in feet and inches) for both, the household head and wife, which I use to calculate the BMI of each spouse, defined as an individual's body weight in pounds divided by squared height in inches and multiplied by a conversion factor of 703. Oreffice and Quintana-Domeque (2010) have shown that nonresponse to body size questions appears to be very small in the PSID data. Specifically, item nonresponse for husband's and wife's height is below 1.4 percent in each year, for husband's weight is below 2.2 percent in each year. Regarding wife's weight, item nonresponse is below 5.5 percent in each year.

All married household heads with spouse present are males, so I refer to each couple as husband and wife, respectively. I confine my study to males age 65 or younger as this is the maximum age range when marital status changes and parenthood happened in this dataset, which is the primary focus of this study. Males whose wives died during the analyzed time period were excluded from the sample. Moreover, to focus on social influence of marriage and parenthood and eliminate difficult to control for health-related factors I exclude individuals with major health issues that may affect their weight, such as severe disability, diabetes, etc. There are no sample exclusions based on BMI.

The final dataset is a strongly balanced panel of 8 biennial waves and a sample of 8,729 males, which amounts to 97% of the entire 2013 PSID sample. 90% of them were married at some point during the observed time and 30.5% lived with children under 19 in the household. Moreover, over 24.1% became married during the analyzed period, almost 12% became divorced and 39% became a father. Detailed descriptive statistics are presented in tables 1 and 2.

Regarding the degree of missing observations, for the dependent variable male BMI fewer than 90 observations were missing in subsample restricted by age and health for the estimation. Moreover, the proportion of missing observations for the explanatory variables such as marital status changes and pregnancy and early parenthood variables are less than 5%. In this study, no imputation methods were used. This is due to a relatively large sample size, and importantly, given the way PSID is designed and data is collected there are no reasons to suspect non-random attrition.

This study focuses on males for two reasons. The first one is simply data availability as Panel Study of Income Dynamics dataset focuses on households and male household heads, whereas females and their characteristics are only observed when they are a wife to the household head. Secondly, this study focuses on the social influence that marriage and parenthood may have on an individual BMI, and female BMI will naturally be biologically influenced by pregnancy, whereas male weight fluctuations in the periods before and after childbirth are easier to interpret in the context of social sciences.

2.2 Empirical strategy

Longitudinal data offers two significant advantages for making causal inferences. Firstly, it allows for controlling for unobserved, time-invariant confounder and secondly, it allows to determine the direction of causal relationships. This direction is of particular interest given the number of competing theories hypothesizing the link between marital status and BMI. In a similar manner that the relationship between happiness and marital status is not easy identify, namely whether marriage makes people happier or whether happier people simply are more likely to find a partner and become married, the causal link between marriage and BMI is not straightforward to establish. Interestingly, whereas happiness understood as a set of general attitudes toward life is not likely to change as a character feature, BMI is subject to change and dependent on individual's actions.

Moreover, the panel structure of the data opens up a possibility of a dynamic analysis. There are two reasons for the autoregressive specification in this study. Firstly, intuitively there is a true state dependence, an inertia of body mass. The best predictor of individual's BMI in any given period is their BMI in the last observed period. Moreover, individual differences in weight are largely attributable to genetic factors (Friedman (2003), Flier (2004)). The male BMI autocorrelation in the data is significant at 0.01 level and is equal to 0.856 for African-American, 0.840 for Asian, 0.690 for Latino and 0.883 for white males.

2.2.1 Linear dynamic IV panel data estimation

Unlike static panel data models, dynamic panel data models include lagged levels of the dependent variable as regressors. Since lags of the dependent variable are necessarily correlated with the idiosyncratic error (the observation-specific zero-mean random-error term which is analogous to the random-error term of cross-sectional regression analysis), traditional static panel data model estimators such as the fixed effects and random effects estimators are inconsistent due to presence of endogenous regressors. This study employs linear dynamic instrumental variable panel-data estimation based on a generalized method of moments estimator by Arellano and Bover (1995) that uses first differencing to remove unobserved heterogeneity and further developed by Blundell and Bond (1998) as a system estimator that uses additional moment conditions.

Treating BMI as an autoregressive process and taking advantage of the panel structure of the data allows for examining the impact of both, state and changes regarding marital status and parenthood, on individual BMI trajectory. Moreover, the GMM system estimation allows for a wide range of control variables as it permits the use time-invariant variables in the model. Variable choice and results are discussed in detail in the next section. The estimations are carried out using `xtdpdsys` command in Stata 14. In post-estimation tests hypothesis of no autocorrelation was rejected at second order, hence moment conditions were verified to be valid. This is important as under the null hypothesis of no second-order autocorrelation the use of lagged values of the dependent variable as instruments would lead to model misspecification.

2.2.2 Estimation approach

This article analyzes male BMI changes over time as an autoregressive process and examines factors coinciding with BMI fluctuations. First part of this study examines a sample consisting of married and non-married males and investigates static and dynamic effects of marital status and parenthood. The second part focuses on married males and, in addition to the previous effects, examines the effect of wife's BMI and other characteristics on male weight fluctuations. The reason behind the two different subsamples is that the first one is used to estimate the static and dynamic effects of marriage and parenthood as compared to the general population of all males, married and single, and the second subsample allows for a focused analysis of weight fluctuations of married males and specifically, what is the impact of beginning and end of marriage on BMI, and to what extent husband's and wife's BMI are linked capturing a shared lifestyle.

By taking full advantage of the panel structure of the data and controlling for a number of socioeconomics variables, this study can analyze the impact of a wide set of marriage and children related life events on male BMI. Significantly, it can examine how much of the weight gain is simply due to being married and how much is due to the dynamic effect of becoming married, divorced and having children. Given competing hypotheses regarding the link between marital status and BMI, a dynamic IV panel estimation offers a solution to many causality issues present in a cross-sectional approach.

Recall that PSID is a biennial survey. Therefore, changes in marital status are observed at two year intervals. For instance, t_M denotes first observed period after becoming married, where $t_M = 1$ if the individual became married and $t_M = 0$ otherwise. t_{M+2} denotes the following period, two years later. However, childbirth is tracked in the questionnaires every year. Hence, as is evident in tables 5 and 6, parenthood time effects are constructed annually and marital status time effects biennially.

Unfortunately, due to frequently changing household heads, the full marital history is not logged for individuals in this data. As the order of marriages is not known it is not controlled for in the estimations.

There is a trade-off between the number of lags and leads included in the estimation and the degrees of freedom. For every time effect added the sample is reduced by one period and one more coefficient needs to be estimated. The final number of lags and leads is based on theoretical implications and hypotheses testing requirements. Moreover, more time effects were tested on a consequently smaller sample and the effects were not significant.

2.2.3 Control variables

The set of control variables includes education, income, work status, age and city size. The rationale for factoring in the city size is the possible cultural, demographic, and socioeconomic differences, which may influence *marriage market* incentives, *selection* and spousal behavior in the context of *marriage protection* and *social obligation* theories. The agglomeration size effects are controlled for using Beale code dummy variables published by the U.S. Department of Agriculture. Each county in the U.S. is assigned one of the 9 Beale codes from three metro and six non-metro categories. Indeed, the share of married individuals varies between 86% and 94.3%, the share of individuals who became married in the sample between 18% and 26.8%, and became divorced between 6.2% and 16.4%.

Moreover, reported health status is controlled for in the estimation as it may be correlated with BMI. The causal effect is not a subject of this study and it can clearly work in both directions, i.e. individual's health is poorer due to a high BMI, and one's weight is higher due to ill health. Ethnicities are controlled for with simple indicator variables.

3 Results

3.1 Descriptive statistics

Tables 1, 2, 3 and 4 report detailed descriptive statistics. Tables 1 and 2 describe the entire sample of married and non-married used in the first estimation, the results of which are presented in table 5. Tables 3 and 4 describe the subsample of married males used in the second estimation (results in table 6).

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3.2 Estimated impact of marital status on male BMI

As reported in table 5, controlling for BMI in the previous period, having children under the age of 19 and a set of socioeconomic variables, married men have significantly ($p < 0.001$) higher BMI than non-married men by 0.437 in the entire population (estimation V) and 0.594 in the white male population (estimation I). For reference, one point BMI increase for a man of average height (5 feet 8 inches) and normal weight in US is equal to about 6 pounds.

—- INSERT TABLE 5 ABOUT HERE —–

Interestingly, in the latter subgroup this effect is no longer significant once time effects of becoming married and divorced are accounted for (estimation II and IV). The higher BMI among married men is driven by marital status changes rather than the state of being married. This is not true for the entire sample, however the magnitude of the higher BMI effect among married men is significantly lower (0.391, $p < 0.001$) and even lower when accounting for early fatherhood (0.317, $p < 0.05$).

In all specifications the time period preceding marriage (t_{M-2}) does not coincide with any significant BMI changes. In the first period observed after becoming married (t_M) men tend to have a higher BMI by 0.230 ($p < 0.05$) in the entire population and 0.351 ($p < 0.05$) in the white subsample. The magnitude of these effects is higher when controlling for early fatherhood (0.302 and 0.423 respectively, $p < 0.001$).

It is even higher when measured in the subsample of only married men. Table 6 shows that married men in the first period of their marriage have BMI higher by 0.773-0.993 ($p < 0.001$) depending on specification. Male BMI tends to be higher in two periods following marriage (t_{M+2} and t_{M+4}) but the magnitude of these effects is considerably lower than in the first period after becoming married, especially when compared with the married men population (table 6).

The time period preceding divorce (t_{D-2}) coincides with a decrease in BMI by 0.254-0.281 ($p < 0.05$) across all specifications in table 5 and similarly in the entire population of married men (table 6, estimation V and VI). The highest decrease in BMI is observed in the period following divorce (t_D, table 5), by 0.663-0.665 ($p < 0.001$) in the white male subsample and 0.340-0.354 ($p < 0.001$) in the entire sample. The following period (t_{D+2}) coincides with no significant BMI effects.

3.3 Estimated impact of pregnancy and early fatherhood on male BMI

This study finds that having children under the age of 19 has no BMI effects. There are also no BMI effects in the year before childbirth (t_{CH-1}) in any of the specifications. With the one exception of higher BMI by 0.147 ($p < 0.1$) in subsample of white married males (table 6, estimation II), the year of childbirth (t_{CH}) does not coincide with any BMI effects either. Recall that childbirth is measured at annual intervals, therefore a precise determination of the course of pregnancy is impossible. Still, this study finds no robust significant effects.

—- INSERT TABLE 6 ABOUT HERE —–

Importantly, it is during the subsequent 4 years (t_{CH+1} - t_{CH+4}) that men tend to have higher BMI. In the entire subsample of married men and non-married men fathers (table 5, estimation VII) in the first year after childbirth (t_{CH+1}) men's BMI is higher by 0.104 ($p < 0.1$), by 0.171 ($p < 0.05$) in the next year, 0.334 ($p < 0.001$) three years later, and finally the effect is lower again four years following childbirth (0.149 at t_{CH+4}, $p < 0.05$). These effects are larger in magnitude when factoring in marital status changes (table 5, estimation VIII), however a similar quadratic trend holds. Similar pattern is true for the white male subsample (table 5, estimation III and IV), but with higher values.

Similar dynamics, but with larger effects than the previous estimations, are reported in table 6. In all specifications, male BMI increases related to early fatherhood are largest in year 2 and 3 after childbirth.

3.4 Male BMI as an autoregressive process and wife's BMI

In all presented estimations and in all subsamples lagged male BMI (BMI_{t-1}) is significant ($p < 0.001$) and the autoregressive coefficient is between 0.316 and 0.353.

The values of lagged BMI coefficient are particularly interesting when compared to wife's current BMI, as the former represents a natural inertia and individual characteristics, and the latter plausibly reflects a shared lifestyle. The coefficients associated with wife's BMI presented in table 6 are significant in every estimation ($p < 0.001$) and are between 0.129 and 0.141, on average around 40% of the own lagged BMI effect.

Moreover, dynamic effects of early fatherhood (t_{CH+1} - t_{CH+4}) remain significant even after taking into account wife's BMI. The latter may be because wives due to pregnancy are on a different BMI trajectory.

4 Discussion

Empirical findings presented in table 5 support hypothesis 1 about married males having higher BMI than not married men, which in turn supports *marriage market* and *social obligation theory* and rejects *marriage protection theory*. Moreover, these findings fall in the range of effect sizes previous studies have found, specifically results presented in Mata et al. (2015) based on nine surveys across Europe. The countries closest in size of the marriage effect found in this study are Germany (0.7), France (0.54), and Spain (0.43). Interestingly, according to Eurostat and National Center for Health Statistics divorce rates for these countries are 49% in Germany, 55% in France, 53% in United States, and 61% in Spain. The likely explanation for the inverse relationship between marriage BMI effect size and country divorce rate is provided by the *marriage market theory*. In countries with high divorce rate re-entering the market is more likely, hence the incentives to stay ready for the marriage market are larger and BMI increase related to being married lower.

Note that in estimations presented in table 5 married men are controlled for and their BMI tends to be higher than non-married men, therefore *marriage selection theory* predicts that men about to be married should be fitter than the rest of the population. Hypothesis 2 is rejected and therefore *marriage selection theory* is not supported in the data. Both hypothesis 3 on male BMI increasing in the period following marriage and hypothesis 4 on male BMI decreasing in the time period preceding and following divorce are supported, which strongly supports *marriage market theory*, is consistent with *social obligation theory* and rejects *marriage protection theory.*

There may be other reasons for a decrease in BMI following divorce, which is considered one of the most stressful life events. However, stress or other related psychological reactions such as depression or anxiety are not necessarily linked to a decrease in BMI, they may result in an increase in BMI as well. Gerace and George (1996) found that divorce, falling out with a close friend, and financial stress were associated with weight gain. Given the lack of psychological data, other drivers cannot be ruled out, nevertheless the post-divorce BMI dynamics are highly consistent with *marriage market theory.*

As shown in table 6 married men's BMI is significantly correlated with their wife's BMI supporting hypothesis 5. This is likely the results of Positive Assortative Matching in fitness and other dimensions that impact health and fitness related behavior. Moreover, plausibly the same factors that influence husband's BMI due to *marriage market* or *social obligation theory* impact wife's BMI resulting in a similar dynamic. Yet, spousal BMI trajectories are not perfectly aligned, otherwise the marital status change and early fatherhood time effects reported in table 6 would not be significant.

Hypothesis 6 about fathers of children under the age of 19 having higher BMI is rejected based on all estimations. A possible rationale is that although *marriage market* and *social obligation theory* likely extend to having children and therefore may result in male BMI changes, these effects are not constant across stages of parenthood.

Similarly, this work finds little evidence of husbands gaining weight during their wife's pregnancy thereby not supporting hypothesis 7. Indeed, it is the first 4 years following childbirth that are significantly correlated with higher BMI among fathers. This supports hypothesis 8. Theoretically weight gain is expected to be more significant in early fatherhood as then *marriage market* incentives, *social obligations* and *adaptive* benefits are particularly high and this research supports this empirically. The value added of testing hypothesis 8 lies therefore not in differentiation between these theories but rather in finding empirical patterns that support them and may be the basis for future research.

To summarize, this study finds strong evidence in support of the *marriage market theory* and *social obligation theory*, and its impact on male BMI, and rejects *marriage protection theory*. Moreover, no evidence of *marriage selection theory* is found. Finally, given the available data it is difficult to differentiate between *marriage market theory* and *social obligation theory*. These two theories indeed make similar predictions and the difference lies mostly in the unobserved individual motivation. They are not mutually exclusive and likely reinforce one another in their impact on BMI.

5 Conclusion

5.1 Contribution

Current research has relied heavily on cross-sectional data with little work based on longitudinal design across family development. To my knowledge this is the first investigation of factors influencing BMI that (a) implements an IV dynamic panel-data estimation, (b) analyzes a full spectrum of static and dynamic effects of marriage, divorce, pregnancy, and childcare on male BMI, and (c) investigates the correlation between wife's and husband's BMI over time. When panels are not sufficiently long to stretch back before the date of marriage, it may be impossible to correct fully for selection. In its empirical approach this work overcomes some potential issues of selection bias and endogeneity.

The first implication of this study is straightforward, for individuals it is useful to understand what social factors may cause weight fluctuations, especially as common ones as marriage and parenthood. Being aware of potential risks will allow them to make informed decisions. Now, the size of most of the estimated effects is below half a BMI point, the equivalent of 3 pounds for an average male in United States. Moreover, with regards to parenthood the increase in BMI coincide with early fatherhood periods only. Regarding marriage, especially in the subsample of white males, the higher BMI among married men can be accounted for by temporary BMI changes coincident with marital status changes and given the autoregressive nature of the specification, will become smaller over time to revert to the original level. Therefore, this study finds few long-term effect and likely limited impact on long-term health.

Moreover, as the findings of this study highlight the importance of social context for body weight, they may have broader practical implication for weight loss and obesity prevention program design, participants' expectation management and efficacy evaluation. Understanding how social factors affect body weight patterns and which effects are temporary and which are permanents are important not only for weight loss programs but may be useful also for diagnostic purposes in cases where weight changes are a common symptom of health disorders. How social factors should be practically incorporated into a clinical discussion of men's health, and how obesity preventions could be better tailored for married men and new fathers and what are the relevant distinctive needs of these populations are an interesting basis for future research.

5.2 Limitations

One of the limitations of this study lies in the biennial survey waves. More frequent observations would allow for more precise insights into the dynamic effects of marriage and parenthood on BMI. Moreover, given the design of the PSID dataset, only the male BMI fluctuations could be analyzed in this study.

There is also no data about health related behaviors such as eating and exercise habits. This is especially relevant to two aspects of this study. First, although the majority of the results is robust across subsamples, there are observed differences between racial groups. Without more detailed data it is difficult to analyze the underlying reasons. Averett et al. (2008b) also find that separate analyses by race and ethnicity reveal substantial differences in the response of BMI to relationship status across these groups. Secondly, the predictions of both, *marriage market* and *social obligation theory*, regarding marriage and BMI are supported by this study and, although these are not mutually exclusive, without data on food and health related behavior it is impossible to empirically differentiate between them.

Regarding the links between fatherhood and BMI, as mentioned in the introduction, the analysis was largely exploratory. This study finding no significant empirical relationship between fatherhood overall and BMI may likely be due to the high variability of fathers' behaviour, for instance the amount of time spend caring for children and in paid work. There are multiple determinants of these choices that are not studied in this research.

Finally, a longer panel would allow to analyze more time effects. Clearly the price to pay for lagging and leading variables is loss of observations. In this work the structure of time effects was chosen to test patterns of BMI fluctuations in the context of theoretical predictions while maximizing the sample size.

References

Manuel Arellano and Olympia Bover. Another look at the instrumental variable estimation of error-components models. *Journal of econometrics*, 68(1):29–51, 1995.

Susan L Averett, Asia Sikora, and Laura M Argys. For better or worse: relationship status and body mass index. *Economics & Human Biology*, 6(3):330–349, 2008a.

Susan L Averett, Asia Sikora, and Laura M Argys. For better or worse: relationship status and body mass index. *Economics & Human Biology*, 6(3):330–349, 2008b.

Susan L Averett, Laura M Argys, and Julia Sorkin. In sickness and in health: an examination of relationship status and health using data from the canadian national public health survey. *Review of Economics of the Household*, 11(4):599–633, 2013.

Kylie Ball, Gita Mishra, and David Crawford. Which aspects of socioeconomic status are related to obesity among men and women? *International journal of obesity*, 26 (4):559–565, 2002.

Kai H Bellows-Riecken and Ryan E Rhodes. A birth of inactivity? a review of physical activity and parenthood. *Preventive medicine*, 46(2):99–110, 2008.

Jerica M Berge, Nicole Larson, Katherine W Bauer, and Dianne Neumark-Sztainer. Are parents of young children practicing healthy nutrition and physical activity behaviors? *Pediatrics*, 127(5):881–887, 2011.

Richard Blundell and Stephen Bond. Initial conditions and moment restrictions in dynamic panel data models. *Journal of econometrics*, 87(1):115–143, 1998.

Ronald E Bulanda. Paternal involvement with children: The influence of gender ideologies. *Journal of Marriage and Family*, 66(1):40–45, 2004.

Jacqueline F Clinton. Physical and emotional responses of expectant fathers throughout pregnancy and the early postpartum period. *International Journal of Nursing Studies*, 24(1):59–68, 1987.

Lauren Dinour, May May Leung, Gina Tripicchio, Sahar Khan, and Ming-Chin Yeh. The association between marital transitions, body mass index, and weight: a review of the literature. *Journal of obesity*, 2012, 2012.

Robin S Edelstein, William J Chopik, Darby E Saxbe, Britney M Wardecker, Amy C Moors, and Onawa P LaBelle. Prospective and dyadic associations between expectant parents prenatal hormone changes and postpartum parenting outcomes. *Developmental psychobiology*, 59(1):77–90, 2017.

Alison E Field, Eugenie H Coakley, Aviva Must, Jennifer L Spadano, Nan Laird, William H Dietz, Eric Rimm, and Graham A Colditz. Impact of overweight on the risk of developing common chronic diseases during a 10-year period. *Archives of internal medicine*, 161(13):1581–1586, 2001.

Jeffrey S Flier. Obesity wars: molecular progress confronts an expanding epidemic. *Cell*, 116(2):337–350, 2004.

Jeffrey M Friedman. A war on obesity, not the obese. *Science*, 299(5608):856, 2003.

Craig F Garfield, Greg Duncan, Anna Gutina, Joshua Rutsohn, Thomas W McDade, Emma K Adam, Rebekah Levine Coley, and P Lindsay Chase-Lansdale. Longitudinal study of body mass index in young males and the transition to fatherhood. *American journal of men's health*, 10(6):NP158–NP167, 2016.

Terence A Gerace and Valerie Anne George. Predictors of weight increases over 7 years in fire fighters and paramedics. *Preventive medicine*, 25(5):593–600, 1996.

Lee T Gettler, Mallika S Sarma, Rieti G Gengo, Rahul C Oka, and James J McKenna. Adiposity, cvd risk factors, and testosterone: variation by partnering status and residence with children in us men. *Evolution, Medicine, and Public Health*.

Lee T Gettler, Thomas W McDade, Alan B Feranil, and Christopher W Kuzawa. Longitudinal evidence that fatherhood decreases testosterone in human males. *Proceedings of the National Academy of Sciences*, 108(39):16194–16199, 2011.

Rebecca Glauber and Kristi L Gozjolko. Do traditional fathers always work more? gender ideology, race, and parenthood. *Journal of marriage and family*, 73(5):1133–1148, 2011.

Peter B Gray and Kermyt G Anderson. *Fatherhood: Evolution and human paternal behavior*. Harvard University Press, 2010.

Beth A Hahn. Marital status and women's health: The effect of economic marital acquisitions. *Journal of Marriage and Family*, 55(2):495, 1993.

Guido Heineck. Height and weight in germany, evidence from the german socio-economic panel, 2002. *Economics & Human Biology*, 4(3):359–382, 2006.

Haomiao Jia and Erica I Lubetkin. The impact of obesity on health-related quality-of-life in the general adult us population. *Journal of public health*, 27(2):156–164, 2005.

Marina Selini Katsaiti. Obesity and happiness. *Applied Economics*, 44(31):4101–4114, 2012.

Gayle Kaufman and Peter Uhlenberg. The influence of parenthood on the work effort of married men and women. *Social forces*, 78(3):931–947, 2000.

France Kittel, RM Rustin, M Dramaix, Guy De Backer, and Marcel Kornitzer. Psycho-socio-biological correlates of moderate overweight in an industrial population. *Journal of psychosomatic research*, 22(3):145–158, 1978.

Thomas Klein. durch dick und dünn.zum einfluss von partnerschaft und partnermarkt auf das körpergewicht. *KZfSS Kölner Zeitschrift für Soziologie und Sozialpsychologie*, 63(3):459–479, 2011.

Petter Lundborg, Paul Nystedt, and Björn Lindgren. Getting ready for the marriage market? the association between divorce risks and investments in attractive body mass among married europeans. *Journal of Biosocial Science*, 39(04):531–544, 2007.

Jutta Mata, Ronald Frank, and Ralph Hertwig. Higher body mass index, less exercise, but healthier eating in married adults: Nine representative surveys across europe. *Social Science & Medicine*, 138:119–127, 2015.

Nelly Mauras, Valerie Hayes, Susan Welch, Annie Rini, Kevin Helgeson, Maryanne Dokler, Johannes D Veldhuis, and Randall J Urban. Testosterone deficiency in young men: marked alterations in whole body protein kinetics, strength, and adiposity 1. *The Journal of Clinical Endocrinology & Metabolism*, 83(6):1886–1892, 1998.

Andrea L Meltzer, Sarah A Novak, James K McNulty, Emily A Butler, and Benjamin R Karney. Marital satisfaction predicts weight gain in early marriage. *Health psychology*, 32(7):824, 2013.

Ali H Mokdad, Earl S Ford, Barbara A Bowman, William H Dietz, Frank Vinicor, Virginia S Bales, and James S Marks. Prevalence of obesity, diabetes, and obesity-related health risk factors, 2001. *Jama*, 289(1):76–79, 2003.

Sankar Mukhopadhyay. Do women value marriage more? the effect of obesity on cohabitation and marriage in the usa. *Review of Economics of the Household*, 6(2): 111–126, 2008.

Kei M Nomaguchi and Suzanne M Bianchi. Exercise time: Gender differences in the effects of marriage, parenthood, and employment. *Journal of Marriage and Family*, 66(2):413–430, 2004.

Henry Noppa and Calle Bengtsson. Obesity in relation to socioeconomic status. a population study of women in göteborg, sweden. *Journal of Epidemiology and Community Health*, 34(2):139–142, 1980.

Sonia Oreffice and Climent Quintana-Domeque. Anthropometry and socioeconomics among couples: Evidence in the united states. *Economics & Human Biology*, 8(3): 373–384, 2010.

Anna Sanz-de Galdeano. The obesity epidemic in europe. 2005.

Jeffery Sobal and Barbara S Rauschenbach. Gender, marital status, and body weight in older us adults. *Gender Issues*, 21(3):75–94, 2003.

Erik Reidar Sund, Andy Jones, and Kristian Midthjell. Individual, family, and area predictors of bmi and bmi change in an adult norwegian population: findings from the hunt study. *Social science & medicine*, 70(8):1194–1202, 2010.

Kenneth E Thorpe, Curtis S Florence, David H Howard, and Peter Joski. The impact of obesity on rising medical spending. *Health Affairs*, 23:W4, 2004.

Debra Umberson, Hui Liu, and Daniel Powers. Marital status, marital transitions, and body weight. *Journal of Health and Social Behavior*, 50(3):327–343, 2009.

Debra Umberson, Hui Liu, John Mirowsky, and Corinne Reczek. Parenthood and trajectories of change in body weight over the life course. *Social Science & Medicine*, 73(9):1323–1331, 2011.

Tommy LS Visscher and Jacob C Seidell. The public health impact of obesity. *Annual review of public health*, 22(1):355–375, 2001.

Sven E Wilson. Marriage, gender and obesity in later life. *Economics & Human Biology*, 10(4):431–453, 2012.

David Withrow and DA Alter. The economic burden of obesity worldwide: a systematic review of the direct costs of obesity. *Obesity reviews*, 12(2):131–141, 2011.

Table 1: Table 1: Descriptive statistics: married and non-married males

Variable	Mean	Std. Dev.	Min	Max
BMI	28.085	4.641	17.693	56.24
Age	44.741	9.665	19	65
Log income	9.848	3.074	0	15.466
Sample size				
Number of individuals	8,729			
Number of observations	35,376			

Table 2: Binary variables and age distribution: married and non-married males

	Percentage share
Age 18-20	0.01
21-30	4.83
31-40	28.13
41-50	33.97
51-60	25.51
61-65	7.56
Married	90.3
Has children under 19 years old	61.7
Timing variables	
If during the observed period of time	
Became married	24.1
Became divorced	11.7
Became a father	39.0
Completed high school	88.2
Graduated university	35.5
Employed	89.7
Searching for a job	4.1
African-American	18.3
Asian	2.1
Latin	1.6
White	74.4

Table 3: Descriptive statistics: married males and their wives

Variable	Mean	Std. Dev.	Min	Max
Husband's				
BMI	28.141	4.638	18.946	56.24
Age	44.967	9.513	23	65
Log income	9.909	3.047	0	15.466
Wife's				
BMI	26.1	5.976	17.555	62.645
Age	43.113	9.576	17	72
Log income	7.726	4.347	0	13.236
Sample size				
Number of individuals	8,023			
Number of observations	30,434			

Table 4: Binary variables and age distribution

	Percentage share
Husband's variables	
Age 21-30	3.89
31-40	28.14
41-50	34.55
51-60	25.77
61-65	7.65
Has children under 19 years old	66.4
Became married	20.0
Became divorced	7.1
Became a father	41.0
Completed high school	88.8
Graduated university	36.8
Employed	90.5
Searching for a job	3.5
African-American	17.1
Asian	2.1
Latin	1.8
White	75.4
Wife's variables	
Completed high school	91.6
Graduated university	38.6
Homemaker	20.5

Table 5: The impact of marriage, divorce and early parenthood on men's BMI: dynamic panel regression coefficients

BMI_t	White males				Entire sample			
	I	II	III	IV	V	VI	VII	VIII
BMI_{t-2}	0.338***	0.334***	0.337***	0.333***	0.336***	0.330***	0.335***	0.329***
	(.018)	(.018)	(0.018)	(.018)	(.015)	(.015)	(.015)	(.015)
If he is married	**0.594*** **	0.118	**0.586*** **	0.050	**0.437*** **	**0.391*** **	**0.427*** **	**0.317** **
	(0.063)	(0.160)	(0.064)	(0.163)	(0.064)	(0.137)	(0.065)	(0.137)
If he has children	-0.022	-0.028	-0.046	-0.069	0.011	0.004	0.006	-0.011
	(0.080)	(0.099)	(0.081)	(0.100)	(0.075)	(0.090)	(0.076)	(0.091)
Marriage time effects								
t_{M-2}		0.039		0.056		0.077		0.086
		(0.123)		(0.123)		(0.101)		(0.100)
t_M		**0.351** **		**0.423*** **		**0.230** **		**0.302*** **
		(0.116)		(0.118)		(0.075)		(0.076)
t_{M+2}		**0.267** **		**0.292*** **		**0.218** **		**0.243*** **
		(0.090)		(0.090)		(0.069)		(0.070)
t_{M+4}		**0.254*** **		**0.246*** **		**0.295*** **		**0.291*** **
		(0.072)		(0.071)		(0.064)		(0.064)
Divorce time effects								
t_{D-2}		**-0.281** **		**-0.271** **		**-0.254** **		**-0.256** **
		(0.120)		(0.121)		(0.105)		(0.104)
t_D		**-0.663*** **		**-0.665*** **		**-0.340*** **		**-0.354*** **
		(0.149)		(0.149)		(0.133)		(0.133)
t_{D+2}		-0.134		-0.103		0.033		0.039
		(0.105)		(0.105)		(0.115)		(0.115)
Childbirth time effects								
t_{CH-1}			-0.039	0.064			0.068	0.048
			(0.075)	(0.010)			(0.078)	(0.094)
t_{CH}			0.080	0.123			0.035	-0.191
			(0.065)	(0.080)			(0.059)	(0.074)
t_{CH+1}			**0.102***	**0.325*** **			**0.104***	**0.247** **
			(0.063)	(0.078)			(0.062)	(0.078)
t_{CH+2}			**0.179*** **	**0.279*** **			**0.171** **	**0.227** **
			(0.056)	(0.071)			(0.058)	(0.072)
t_{CH+3}			**0.237*** **	**0.325*** **			**0.334*** **	**0.327*** **
			(0.061)	(0.068)			(0.068)	(0.077)
t_{CH+4}			0.041	**0.098***			**0.149** **	**0.168** **
			(0.052)	(0.059)			(0.049)	(0.057)
Number of individuals	6,444	6,444	6,444	6,444	8,729	8,729	8,729	8,729
Number of observations	26,316	26,316	26,316	26,316	35,376	35,376	35,376	35,376
Avg number of obs per individual	4.08	4.08	4.08	4.08	4.05	4.05	4.05	4.05

1) Robust standard errors in parentheses.
2) *: $p < 0.10$, **: $p < 0.05$, ***: $p < 0.001$
3) BMI_{t-2} denotes lagged BMI.
4) $t_M = 1$ denotes first observed period after becoming married.
5) $t_D = 1$ denotes first observed period after becoming divorced.
6) $t_{CH} = 1$ denotes the year period of childbirth.

Table 6: The impact of marriage, divorce and early parenthood on married men's BMI: dynamic panel regression coefficients

BMI_t	White males			All married males		
	I	II	III	IV	V	VI
BMI_{t-2}	0.336***	0.353***	0.328***	0.324***	0.336***	0.316***
	(0.019)	(0.019)	(0.019)	(0.017)	(0.017)	(0.017)
Wife's BMI_t	**0.129*** **		**0.138*** **	**0.134*** **		**0.141*** **
	(0.013)		(0.015)	(0.011)		(0.012)
If he has children	-0.054	-0.055	-0.080	-0.018	-0.009	-0.018
	(0.087)	(0.105)	(0.106)	(0.083)	(0.099)	(0.101)
Marriage time effects						
t_M		**0.793*** **	**0.894*** **		**0.773*** **	**0.993*** **
		(0.124)	(0.126)		(0.110)	(0.116)
t_{M+2}		**0.355*** **	**0.333*** **		**0.399*** **	**0.402*** **
		(0.099)	(0.099)		(0.088)	(0.089)
t_{M+4}		**0.320*** **	**0.338*** **		**0.395*** **	**0.416*** **
		(0.083)	(0.085)		(0.078)	(0.080)
Divorce time effects						
t_{D-2}		-0.071	-0.015		**-0.276** **	**-0.219* **
		(0.124)	(0.126)		(0.129)	(0.130)
Childbirth time effects						
t_{CH-1}		-0.015	-0.030		0.099	0.134
		(0.114)	(0.110)		(0.106)	(0.103)
t_{CH}		**0.147* **	-0.037		0.061	-0.032
		(0.088)	(0.089)		(0.083)	(0.083)
t_{CH+1}		**0.314*** **	**0.212** **		**0.291*** **	**0.222** **
		(0.085)	(0.084)		(0.084)	(0.084)
t_{CH+2}		**0.371*** **	**0.334*** **		**0.340*** **	**0.339*** **
		(0.079)	(0.080)		(0.077)	(0.078)
t_{CH+3}		**0.380*** **	**0.320*** **		**0.401*** **	**0.366*** **
		(0.070)	(0.066)		(0.080)	(0.078)
t_{CH+4}		**0.155** **	**0.134** **		**0.220*** **	**0.184** **
		(0.062)	(0.063)		(0.060)	(0.060)
Number of individuals	6,007	6,007	6,007	8,023	8,023	8,023
Number of observations	22,950	22,950	22,950	30,434	30,434	30,434
Avg number of obs per individual	3.821	3.821	3.821	3.793	3.793	3.793

1) Robust standard errors in parentheses.
2) *: $p < 0.10$, **: $p < 0.05$, ***: $p < 0.001$
3) BMI_{t-2} denotes lagged BMI.
4) $t_M = 1$ denotes first observed period after becoming married.
5) $t_D = 1$ denotes first observed period after becoming divorced.
6) $t_{CH} = 1$ denotes the year period of childbirth.
7) Homemaker- majority of her time is devoted to household tasks.